24. *Bulimus Walli*, mihi.

B. testa acuminato-elongata, gracili, minute umbilicata; anfractibus octo, minute transversim striatis; intense brunnea; apertura parva; columella parum reflexa; labro simplici.

Hab. Kalka, Rockhampton (W. S. Wall, jun.).

Diam. 0·12, alt. 0·44 unc. Mus. C.

The same type of shell as *B. Tuckeri.*

25. *Bulimus Onslowi*, mihi.

B. testa subobtecte perforata, ovata, solidiuscula, striata, albescente vel pallide cornea fasciis crebris transversalibus rufescentibus; spira conica, obtusa; sutura profunda; anfractibus quatuor, parum convexis, striis plurimis semiregularibus spiralibus transversisque sculptis, ultimo ventroso, spiram duplo dimidioque superante; apertura subverticali, angulato-ovali, intus pallide plumbea; peristomate simplici, tenui; margine columellari albido, reflexo, basi adnato.

Long. 0·85, diam. 0·60 unc.

Hab. Dirk Hartog's Island, Shark Bay, Western Australia (Onslow). Australian Museum.

26. *Bulimus Jacksonensis.*

B. testa ovato-conica, imperforata; anfractibus quatuor, vix convexiusculis, glabris, nitidis, ultimo duplo ceteros æquante; spira obtusa; sutura impressa; apertura ovata; labro simplici, corneo pellucidoque; columella recta.

Long. 0·14, diam. 0·05 unc.

Hab. Darling Point, Port Jackson (King &c.).

XX.—*Histological Researches on the Formation, Development, and Structure of the Vegetable Cell.* By Prof. H. Karsten.

[Concluded from p. 133.]

§ XI.

Intercellular substance.—Cuticle.—Metamorphosis of the substance of the different membranes of a joint-cell, and their development independently of the operation of a primordial utricle.—Formation of layers by the cell-membrane.—Difference between a cell-membrane and a layer of cell-membrane.—Varieties and causes of the transformations of the originally structureless cell-membrane.—Untenability of the hypothesis of a primordial sac.

There are two antagonistic hypotheses in histology, viz. that of endogenous cell-formation and that of cell-fission; but there is a general concurrence on this point—that the walls of existing cells may be thickened in layers.

By this laminated thickening (of the true nature of which, however, very different conceptions are adopted) the adherents of the fission-theory account not only for the nested membranes occurring in every individual cell, but even for the general cellular envelope of the entire organism (cuticle), and also for the intercellular substance, at least as far as the existence of the latter is admitted by them.

According to this theory, the outer thickening layer of the primitive, freely produced cell, which forms the basis of the developing organism, must be the commencement of the enveloping membrane; it is produced whilst the cell, constantly increasing in volume, has its space repeatedly divided into smaller compartments by fold-formation of its inner layer (the primordial sac).

Each of the cells thus produced is supposed to secrete the connective mass (intercellular substance) which unites them into a coherent tissue, just as the various layers of which the cell-wall consists are secreted externally and internally by the primordial sac.

On the other hand, those histologists who believe that cells do not originate by constriction, but as independent structures within the fluid contents of the mother cell, and who are convinced that, along with the production of laminæ by the assimilative faculty of the cell-wall, there is also a simultaneous chemical change, and in many cases a remarkable regeneration of the mother cell by the endogenous development of daughter cells—such observers dissent from the previous views regarding the origin of intercellular substance only so far as to assume that the growth of laminæ does not arise from an excretion of the original cell-membrane (the primordial sac), but by intussusception into its mass. They also conceive that the intercellular substance, which is doubtless present in the interspaces of the active cells, was at one time the outermost cell-membrane or layer of a cell-membrane, but that this has become changed by the agency of assimilation in such a manner that it is subjected to the solvent power of the nutritive fluid which soaks the vegetable tissue and becomes received into its mass.

The explanation of the origin of the membranous envelope (cuticle) as an excretion of the epidermis does not harmonize with the visible peculiarities of this lamina as pointed out by Brongniart, who describes it as a delicate homogeneous covering of the epidermis; for should the laminæ of the cell-wall, together with the cuticle, arise simply by excretion from the cells, the homogeneous nature of this membranous investment would be destroyed by the first act of division of the germ-cell, as it would then be secreted first by two and soon afterwards by four or many cells, and finally by the epidermic layer. In accordance with this mode of origin, it would rather have presented a structure agreeing with the contour of the epidermic cells, such as indeed is possessed by the outermost coat of the epidermis belonging to the epidermic layers, characterized by Mohl as "cuticular layers."

If, however, the homogeneous cuticle, which, when old, may be slightly granular or striated, but which exhibits no cellular structure, is to be regarded as derived from the first excretion-layer of the first cell, we must ascribe to this first excretion-layer the property of appropriating material out of its vicinity; and as it cannot anywhere find materials ready prepared so as to add them to its substance by apposition in the fashion of inorganic growth, we shall further have to attribute to it the property of preparing the necessary materials for itself from heterogeneous matters by virtue of the chemical affinity inherent in its own substance.

To this first excretion-layer of the first cell we must thus ascribe the faculties which ought essentially to belong only to the interior cell, to which it is indebted for its existence. It must possess in itself the properties of the assimilating membrane; it must be, not a mechanically excreted educt of the exuded cell-juice, but a portion of an organized structure, the membrane of an independent cell, within which the enclosed cells have been produced.

With this view the results of the investigation of the developmental history of this structure published by me in 1848 (Bot. Zeitung) perfectly agree.

I ascertained then, and can repeat the experiment with facility at any time, that by means of endosmotic fluids (such as dilute mineral acids, solution of sugar, &c.) a delicate structureless membrane may be detached from the young embryo in its different stages of development in the embryo-sac: the youngest state of this membrane is consequently the membrane of the germinal cell; and it may be demonstrated by the same means to be the outermost coat of all still cambial organs of the plant in course of development.

The objection that a cell cannot so far enlarge itself as to overspread an entire plant, originating from the idea of the growth of the cell-membrane by accretion, is consequently not applicable; for the cell-membrane, and more particularly the cuticle, as already said, cannot increase itself by accretion, the material of which it is composed not being found in solution in its vicinity.

An independent growth of the cuticle, in many cases quite unconnected with the adjoining cell-wall, may be recognized with certainty in the examples referred to at page 423, vol. xiii. and represented in Plate VI. figure 45.

Very commonly, indeed, an intimate reciprocal relation does appear to exist between the cuticle and the neighbouring cells; but this can scarcely ever be regarded as a production of the former from the latter.

Although the want of a cuticle upon the epidermic tissue of the roots, while it occurs upon stems of the same age, might seem to give support to such an explanation, still the cork-formation occurring in the latter immediately after an injury to the cuticle, or the cuticular layers replacing it, may be regarded as giving probability to a directly opposite supposition. And indeed the cuticle is really present at an earlier period than the epidermis.

The peculiar development of the membranes of *Œdogonium* also affords an equally remarkable and interesting proof of the mutual dependence of neighbouring cells. For the horizontal rupture of the integument in a circular form over the adjacent fold of the joint-cell is not to be explained merely by the fact that the extraordinary thickening of the membrane of the joint-cell assimilates to itself all nutritive material, and therefore excretes nothing for the integument. The latter must then always remain thinner at this spot than in other parts,—which, however, is not the case. On the contrary, the cuticle appears to be quite uniform throughout up to the period of the rupture; its rupture is preceded by a disintegration of its substance, almost appearing as if it were decomposed into a deliquescent mucilaginous and an insoluble granular part, as may be seen especially in the cases described on page 284, vol. xiii. (Pl. V. fig. 25), in which no extension of the joint-cell has taken place.

The conditions observed in *Spirogyra* even lead rather to the supposition that the products of the metamorphosis of the cuticle may serve as nourishment for the adjacent membrane of the joint-cell.

It is true that the *Spirogyræ,* and probably all the Conjugatæ, possess no true cuticle, but the primary membranes of the mother cell fulfil the function of this integument; and the phenomena presented by these may therefore probably be interpreted as analogous to those of cuticular development.

If *Spirogyra orthospira* be allowed to vegetate for some time in distilled water, the very thick cuticular layer is gradually reduced until at last it almost completely disappears, a very thin innermost lamina excepted. In carbonic-acid water this phenomenon takes place still more rapidly, but simultaneously the primary membranes of the joint-cell increase in thickness. On the contrary, if organic compounds be added to the water, the cuticular layer is very perceptibly thickened; the joint-cells cohere more firmly together, and are not separable with the same facility as in the former case.

The most simple explanation of these phenomena appears to me to be, not that the cuticular layer is more or less completely regenerated according as the joint-cells are more or less well supplied with nourishment, but rather that it assimilates the nutritive material present, which reaches it both from without and from within, and transfers this to the inner cells, or, if this nutritive material be wanting, continues the function of nutrition at the expense of its own substance, and is finally destroyed by atrophy, whilst the neighbouring membrane of the joint-cells becomes unusually thickened.

In like manner, also, the developing integumentary cell will probably, up to its complete evolution, possess the faculty of assimilating the nutritive fluids by which it is soaked, until at length, earlier or later according to its specific nature, it serves the assimilating inner tissue as nutritive material, even if this be only as a product of oxidation.

Phases of development similar to those of the cuticle have to be passed through by the different membranes and membranous laminæ of each individual cell-system of which the cellular tissue is composed; the product of the liquefaction of the outermost comes at length to serve as nutritive material for the inner ones which are still living, or for those in course of development in other regions of the organism.

As we know that the cellulose membrane formed by the metamorphosis of the earliest, probably nitrogenous, cell-membrane changes by continual interchange of matter not only into lignine, xylogen, cork-substance, resin, and wax, but also into bassorine, gum, mucilage, and sugar, the notion that the formation of cellulose is the object and result of the interchange of matter in the vegetable cell must be modified as follows:—Many, indeed perhaps most, vegetable cells have to pass through this chemical constitution of their membrane as a necessary phase of their development (a phase, however, which has scarcely been attained or exceeded by many of them when the organism to which they belong has already completed its cycle of life); but in many cases the cellulose cell-membrane employs the fluid by which it is permeated for still further changes of substance.

With this are associated other instances, some of them communicated in the preceding pages, of the independent growth of cell-membranes, and indeed of cellulose cell-membranes (as, for example, the peculiar fold-formation of the primary membrane of the joint-cell of *Œdogonium*, p. 285, vol. xiii., Pl. VII. fig. 49), which are opposed to the notion of the excretion of one cell-membrane by the adjacent ones.

And not only does the membrane of the primary cell undergo chemical metamorphosis and accomplish peculiar changes of form independently of the neighbouring cell-membranes, but identical or very similar phenomena exhibit themselves in the membrane of the secondary cells, in the production of their "secondary secretion-layers"; for were the layers of cell-membrane known under this appellation only secretions on the inner surface of a primordial sac, this last structure ought to be visible so long as those laminæ are in process of multiplication.

Nevertheless no membrane is ever to be found between the outer and inner so-called secretion-layers possessing the special characters of the primordial sac. On the contrary, I am satisfied, by repeated observations, that the membrane of the secondary cell which is stained by iodine no longer retains its delicate elastic consistence when the internal secretion-layers make their appearance—a fact that favours the supposition that the substance of which the primordial sac is composed furnishes the thickening layers by a change in the character of its activity.

Restricting myself to preceding examples, I would recall to mind the secondary cell of the pollen mother cell of *Althæa*: no primordial sac can ever be discovered between it and the primary cell, and nevertheless its laminar growth is continued for a long time.

There are even instances where such a transformation of the substance of the membrane may without doubt be detected on the coat of the tertiary cell (the cell-nucleus) whilst this membrane is still far removed from the secondary cell-membrane.

In Pl. V. fig. 16 I have represented a cell such as is present in the neighbourhood of the vascular bundles of many Palms, as for example, *Geonoma, Iriartea, Phœnix*, &c. Within the cell-nucleus of this almost cubical cell there is a collection of oxalate of lime in minute crystalline druses, such as are not unfrequently met with in cells. In these cells I found the membrane of the cell-nucleus which lies close upon the secreted crystalline matter transformed into cellulose—a condition which assuredly will be often encountered.

Moreover, in the globules of *Œdogonium* (fig. 50 *b*) all the membranes of the entire system of cells exhibit a cellulose reaction, though this is not the case in the youngest cells of this same plant; consequently a change of these latter into cellulose must also have been effected in this instance.

The nature of the transformation which the several overlying or nested cells of a cell-tissue progressively undergo depends on the position which these cells occupy in the organism; nevertheless the form which their membrane acquires during the interchange of substance does not depend only on this transformation, but in part also on the nature of their contents.

For example, if the cell-contents are organized, and therefore composed of cell-structures, these usually exercise a perceptible influence on the form of the superadded layers. Both the organized contents and the form of the thickening layers caused by them afford grounds for the discrimination of the different layers that concur in the construction of the cell-system of a tissue-cell.

For as such a cell-system is not only composed of a number of cells, but each of these cells again consists of many superposed layers, it is often difficult to make out the essential nature of any single layer, especially when these laminæ, as not unfrequently happens, are only loosely connected together, or are of dissimilar chemical constitution, or, again, when the membranes of various endogenous cells are of homogeneous consistence, or for other reasons are undistinguishable or inseparable from each other. Under such circumstances it is the rule that the layers of a cell-wall never contain organized bodies; where such are present, the nearest external membrane is the membrane or the innermost lamina of an organized cell.

The layers of deposit may indeed at the time of absorption be separated from each other by fluid materials; but they do not enclose organized forms. On the other hand, many endogenous cells of the system of a tissue-cell contain only fluid, which makes their recognition as cells difficult. Most commonly, however, at least the secondary and the next cells in the interior enclose organized forms.

When, among these organized contents of the secondary cell (consisting of vesicles containing secretion-material and frequently, when the cell is not engaged in the multiplication, of a nucleus), one of these secretion-vesicles becomes so much extended at the expense of the others as to attain the size of the mother cell; the tertiary cell (the cell-nucleus) and the rest of the contents are enclosed between the two membranes, which then become approximated, and from this results the form designated by Unger the "parietal (*wandständiger*) cell-nucleus," which led Schleiden into his above-mentioned erroneous notion of cell-genesis. These forms are developed in fruits which are becoming succulent, as also in cells filled with blue, red, and many kinds of yellow colouring-matter.

But commonly there is a different state of things, the small secretion-vesicles (chlorophyll, starch, mucus, &c.) becoming adherent, during their development, to the internal surface of the membrane of the secondary cell. At a later period, when this membrane begins to undergo a chemical change, and to thicken, these secretory matters become absorbed; the vesicles vanish out of sight, but the spots at which they have adhered, or still may adhere, do not undergo thickening.

The study of the history of development of the porous cells in the pith of *Hoya carnosa,* in the tissue of the stem of *Langsdorffia,* as also that of the porous and scalariform ligneous cells of ferns &c., led me to the knowledge of these conditions of structure*.

At the time it escaped my notice that Unger†, in his instructive examination of the development of the spiral vessels in the root-ends of Monocotyledons, had already arrived at similar results. Unger observed that the youngest vessels arising from the coalescence of series of cells contained a mucilaginous fluid, within which numerous small vesicles soon presented themselves and became adherent to the walls of the vessels, which at a later period underwent thickening, in part in a spiral manner, in the intervals between these vesicles.

A picture of the spiral thickening of secondary cells is furnished by certain diseased states of *Spirogyra nitens,* which have been frequently referred to. When this plant has lain for some time in carbonic-acid water, and is afterwards transferred to pure water or to a very weak endosmotic solution, the chlorophyll-layers are observed to become, in consequence of diosmosis, separated from the swollen secondary walls, as seen in Pl. VII. figs. 65, 66. In these now muco-gelatinous membranes they leave behind them channel-like depressions, the membrane at the parts between them being more strongly thickened, probably from the absence here of impediments to diffusion. The phenomenon is very transitory, as the membrane continues to undergo change by swelling up, and apparently becoming liquefied in the water.

Another picture, likewise, of a spiral arrangement is at times seen in the progress of the changes of the cell-contents of *Mougeotia* when placed in solution of tannin (vol. xiii. p. 418). In this instance the secretion-cells do not adhere to the wall, but occupy the entire cavity of the cell.

Both these examples are probably types of spiral formation as it actually proceeds in nature, though observable with very great difficulty. In every case this formation takes place by means of a thickening of the cell-membrane in the intervals between adherent endogenous vesicles, just as the often observed ridge-like prominences on the secondary pollen mother cells (vol. xiii. p. 483) originate between the pollen-cells, the proper

* De Cella vitali, p. 33, tab. 1. figs. *a–d*; Vegetationsorgane der Palmen, tab. 8. fig. 1 *b*; Bau der Cecropia, Nova Acta, vol. xxiv. tom. I. p. 88, tab. 13. fig. 4; Langsdorffia, Nova Acta, vol. xxvi. tom. II. tab. 63. fig. 5.

† Linnæa, 1841, p. 385, taf. 5. See also Grundz. d. Anat. u. Phys. 1846, pp. 11 & 46.

membranes of which, being subsequently thickened, then appear to be continuations of these ridges.

It is probable that the porous walls are produced sometimes, although but seldom, by mere folds, at other times by thickenings similar to that described in *Spirogyra*, but sometimes also by not only the membrane of the mother cell, but partially those of the vesicles adherent to it, becoming lignified, in the same way as the reticulated outer membrane of spores and pollen-cells and also the simple cellular layer formed by the seed-coverings of the Orchideæ, Burmanniaceæ, Gentianeæ, &c.

That the production of the vessels composed of spiral cells (which are to be regarded as the first vessels in the cambial tissue of the apices of the roots, and therefore, no doubt, also of the buds of the stem and branches) is assisted by the richness of this tissue in organic nitrogenous compounds, was evidenced to me by experiments with roots of *Iriartea*; and that these compounds, by increasing the quantity of the endogenous cellular structures, also appear to induce the general spiral disposition of the organized cell-contents may be assumed from the observations upon the position of the chlorophyll-sac of *Spirogyra* cited at p. 25. Direct special researches will elucidate this point.

Certain retrograde metamorphoses of porous vessels which I have observed appear to me to be capable of furnishing confirmation to the investigations of their anatomical structure made by Unger and myself.

The walls of the thickened porous cells and vessels filled with cork-cells undergo absorption (as described at p. 272, vol. xiii.) in such a manner that the external membranes are the first to disappear. This can be particularly well seen in the much-thickened cells of the medullary sheath, the innermost coats of which, shortly before their complete deliquescence, exhibit pores of considerable size (Pl. V. fig. 15).

Under these circumstances we may not unfrequently detect in the walls of porous vessels in course of absorption a structure which is in accordance with the production of these pores in consequence of the adhesion of vesicles to the inner surface of the cell-membrane which is afterwards porously thickened.

A portion of such a cell-wall, more strongly magnified, is shown in fig. 6. It is composed of almost horizontally disposed annular bodies, imbedded in an intercellular substance, and having interposed between them a homogeneous continuous band cemented to them by the intercellular substance.

That these annular bodies are to be regarded as small cells, thickened strongly all round, and but slightly above and below, is evidenced (leaving out of consideration the already recognized development of the porous membranes) by the similar aspect of the above-mentioned seed-coats &c. The band visible between them is the membrane of the secondary cell thickened internally in ridges between the small vesicles adherent to it; here it separates readily in a spiral direction from the annular bodies, which now and then detach themselves singly, because the original external lamina from which it grew, and to which the now annularly thickened vesicles adhered, is almost entirely absorbed.

The structure of these vascular walls differs from that of the membranes of seeds and pollen-corpuscles in this respect,—that in the latter the cells are immediately contiguous, and form a continuous tissue, whilst in the former the spherical or expanded vesicles are either completely separated or are in contact in one direction only, though at times an actual coalescence takes place between them.

Since the profound researches of Mohl into the structure of the cell-membrane, it has been known that even heterogeneous layers of deposit occur upon the membranes composing one tissue-cell. This remarkable phenomenon may be simply explained by the fact that in such tissue-cells the heterogeneous membranes of different nested cells are closely approximated.

Moreover the external primary cell-membrane (if we leave out of consideration the spiral texture, which is certainly very prevalent) appears almost constantly to be homogeneous, whilst the membrane of the secondary cell very frequently has a peculiar structure; but the tertiary cell, where it attains the dimensions of the secondary one, is likewise structureless.

The cause of these well-known facts, as also of the parallel occurrence of organized structures in one of the endogenous cells, whilst in others there is only fluid, has not hitherto been recognized.

The frequent and almost normal absence of organized bodies in the contents of the primary cell, and of peculiar forms of thickening of its membrane, throws us back upon its developmental history in order to decide whether this homogeneous external membrane of the vegetable cell is the membrane of the primary cell of the cell-system (as which I regard it) or only the first structureless layer of deposit of the second inner cell-membrane, which subsequently becomes thickened in another form. The latter might then be regarded, with respect to the former, as a primordial sac, if Mohl had not established a different conception of this designation (vol. xiii. p. 268).

The examples already cited (vol. xiii. p. 423, figs. 45 & 49) of the perfectly independent construction of contiguous endogenous cells are not favourable to the last-mentioned conception of the matter; and in any case we should have to assume in each cell-system, not a single primordial sac, but as many of these as there are of superimposed cells (*e. g.* figs. 51 & 52, 80–85), even if it were permissible, in opposition to the idea set up by the founder of this theory, to give the name of the primordial sac to that layer of the cell-wall which is the last to give up its original peculiarity.

In this case the denomination employed by me for the tissue-cell, of "a cell-system consisting of cells nested one within the other," might be altered into "a tissue-cell consisting of primordial sacs nested one within the other."

Just as the organism requires the complete, normal, endogenous, serial development and the harmonious cooperation of all its elementary organs, for the perfect unfolding of its typical form and functions, the normal structure and activity of each of these elementary organs depends upon the undisturbed development of all these simple organizations, which stand in an intimate reciprocal relation to each other, the cells engaged in a constant interchange of materials, with a structureless spherical envelope and heterogeneous unorganized contents produced in the plastic juice of the mother cell.

It is only in the duration of the reciprocal action of the contents and membrane—the two constantly changing constituents of the cell—that its organization consists. An absolute stoppage of the change of materials of all its parts is coincident with the cessation of the organizatorial activity of the organism.

The opposite idea—namely that the secretion-structure, the cellulose membrane, just as the calcareous shell is the house of the snail, forms the chamber into which plant-life retires, the house of the plant-cell, and afterwards its tomb—would become, if it found acceptance, the winding-sheet of science.

XXI.—*On a new Generic Type of Fishes discovered by the late* Dr. Leichardt *in Queensland.* By Albert Günther, M.A., M.D., Ph.D.

[Plate VII.]

Sir Daniel Cooper, Sir Philip G. Egerton, and Mr. G. Krefft have favoured me with photographs of a fish obtained by the late Dr. Leichardt in the Burdekin River, which evidently is the type of a new and remarkable genus. The specimen from which the photographs were taken is a dry skin, 15 inches long, preserved in the Australian Museum at Sydney. The photograph sent by Sir P. Egerton was accompanied by a scale taken from the middle of the side of the Sydney specimen, and shows a structure very similar to that of the scales of the